Amendments to the Specification

Replace paragraph [0001] with the following:

Embodiments of the ~~The~~ present invention relate ~~relates~~ generally to control systems for disc drives. More particularly, the present embodiments relate ~~invention relates~~ to improving seek performance in a disc drive by way of a control system employing an improved reference profile for controlling arrival at a track.

Replace paragraph [0013] with the following:

The present embodiments provide ~~invention provides~~ a solution to this and other problems, and offers other advantages over previous solutions.

Replace paragraphs [0014-0015] with the following:

Embodiments of the ~~The~~ present invention provide ~~provides~~ a method and apparatus for controlling the arrival of a disc drive actuator arm assembly using a time-linear arrival profile. Some embodiments ~~A preferred embodiment~~ of the present invention employ ~~employs~~ a closed-loop control system in which velocity is the controlled parameter. A reference velocity is calculated as a function of the current position of the arm assembly and the amount of time left to complete the seek operation, where the first derivative of the reference velocity function with respect to time varies linearly with respect to time. This computed reference velocity is compared to the actual velocity as determined from measuring the position of the arm assembly and the actual command signal applied to the arm assembly motor. An error signal is thus obtained. This error signal is summed with a feedforward signal to achieve the desired command signal, where the feedforward signal is

derived from the measured acceleration of the arm assembly. In some embodiments ~~a preferred embodiment~~, this time-linear arrival is utilized in the second stage of a two-stage arrival sequence, in which the arm assembly follows a constant-acceleration profile during the first stage.

These and various other features as well as advantages which characterize the present embodiments ~~invention~~ will be apparent upon reading of the following detailed description and review of the associated drawings.

Replace paragraphs [0018-0020] with the following:

FIG. 3 is a block diagram of a disc drive actuator arm control system in accordance with embodiments ~~a preferred embodiment~~ of the present invention;

FIG. 4 is a flowchart representation of a process of performing a seek in accordance with embodiments ~~a preferred embodiment~~ of the present invention; and

FIG. 5 is a phase plane diagram depicting the operation of a track arrival using square root and time-linear arrival profiles in accordance with embodiments ~~a preferred embodiment~~ of the present invention.

Replace paragraph [0021] with the following:

Referring now to the drawings, and initially to FIG. 1, there is illustrated an example of a disc drive designated generally by the reference numeral 20. The disc drive 20 includes a stack of storage discs 22a-d and a stack of read/write heads 24a-h. In the depicted example, heads are only shown on the top surface of each platter of the disc driver for simplicity and clarity of the drawing, however, it should be noted that additional heads

are typically provided for the bottom surfaces of each platter as well. Each of the storage discs 22a-d is provided with a plurality of data tracks to store user data. As illustrated in FIG. 1, one head is provided for each surface of each of the discs 22a-d such that data can be read from or written to the data tracks of all of the storage discs. The heads are coupled to a pre-amplifier 31. It should be understood that the disc drive 20 is merely representative of a disc drive system utilizing the present invention and that the present embodiments ~~invention~~ can be implemented in a disc drive system including more or fewer storage discs.

Replace paragraphs [0031-0033] with the following:

The present embodiments provide ~~invention provides~~ a method and apparatus for controlling the arrival of a disc drive actuator arm assembly using a time-linear arrival profile. Some embodiments ~~A preferred embodiment~~ of the present invention employ ~~employs~~ a closed-loop control system in which velocity is the controlled parameter. A reference velocity is calculated as a function of the current position of the arm assembly and the amount of time left to complete the seek operation, where the first derivative of the reference velocity function with respect to time varies linearly with respect to time. This computed reference velocity is compared to the actual velocity as determined from measuring the position of the arm assembly and the actual command signal applied to the arm assembly motor. An error signal is thus obtained. This error signal is summed with a feedforward signal to achieve the desired command signal, where the feedforward signal is derived from the measured acceleration of the arm assembly.

In some embodiments ~~a preferred embodiment~~, the arrival phase of a seek operation is conducted in two stages. In the first stage, the acceleration (which is actually deceleration

in the case of arrival) is a constant and represents an optimum level of acceleration for the voice coil motor. This allows the arm assembly to move at an optimal velocity for as long as practicable. This first stage is said to follow a "square root" velocity profile, because the velocity of the head when acceleration is constant is $\sqrt{2ax}$, where a is the instantaneous acceleration of the head and x is the position of the head as measured from the desired track. In a preferred embodiment, the "desired track" that is used to compute the square root velocity profile may not be the actual track to which the entire seek will take place; an optimal target track for the square root velocity profile is chosen at the beginning in order to optimize the overall seek time.

The second stage is the "time-linear arrival" stage, in which the acceleration of the head varies linearly with respect to time until the acceleration, velocity, and position of the head converge at zero at the desired track. In a preferred embodiment, the point at which the transition from the "square-root" velocity profile stage to the "time-linear arrival" stage takes place is determined before the seek operation takes place, by determining a point at which a smooth transition may be made from the square root profile to the time-linear arrival profile. One of ordinary skill in the art will recognize that such a transition point may be determined by setting one or more of the motion functions (e.g., velocity or acceleration) of one profile equal to the corresponding function(s) from the other profile and solving for the unknown distance at which the acceleration and/or velocity value(s) from both profiles are equal. An example of this transition process is provided in FIG. 5. FIG. 5 is a phase plane diagram of a two-stage arrival in accordance with embodiments ~~a preferred embodiment~~ of the present invention. Graph 500 shows a transition point 502 between a square root velocity profile (solid line) and a time-linear arrival profile (dashed

line) in terms of head velocity and the number of tracks to go in the seek operation. Similarly graph 550 depicts a transition point 552 between a square root velocity profile (solid line) and a time-linear arrival profile (dashed line) in terms of head deceleration and the number of tracks to go in the seek operation.

Replace paragraph [0037-0039] with the following:

where *SamsToGo* represents the number of sampling periods left in the duration of the seek operation. In some embodiments ~~a preferred embodiment~~, these sampling periods correspond to the time periods between successive samples of servo information from the disc to determine the position of the head with respect to the disc's tracks. These motion functions in terms of *SamsToGo* are easily calculated in fixed-point arithmetic in digital circuitry or in a stored-program computer. In a preferred embodiment, *SamsToGo* itself is predetermined according to empirical data gathered during the design process of the disc drive, as this number will be specific to a particular mechanical and electrical design. Embodiments ~~A preferred embodiment~~ of the present invention determine ~~determines~~ a reference velocity $v_{ref}(t)$ using the above function definition for $v(t)$ by applying ~~the substituted~~ an empirically estimated position value for x and the estimated number samples remaining as *SamsToGo*. $v_{ref}(t)$ is then compared with an empirically estimated velocity figure to derive an error signal, which is then used to correct the command signal fed to the voice coil motor.

FIG. 3 is a block diagram of a disc drive actuator arm control system in accordance with embodiments ~~a preferred embodiment~~ of the present invention. The block diagram represented in FIG. 3 is representative of control circuitry or program code for computer-

based control. Although this discussion will refer to the elements described in FIG. 3 in terms of components of a control circuit (e.g., multiplier 302, etc.), it should be understood by those skilled in the art that the control system described in FIG. 3 may be implemented in program code for execution in a stored-program computing device (e.g., a microprocessor, microcontroller, DSP, or other device that executes software), in dedicated circuitry, or in a combination of both. Each block in FIG. 3 may be implemented as one or more instructions in a programming language such as C, for example.

In <u>some embodiments</u> ~~this preferred embodiment~~, while the square root profile is being used, a feedforward signal 300 is generated based on the maximum current drive for plant 318, which, in <u>some embodiments</u> ~~a preferred embodiment~~, is a voice coil motor. Feedforward signal 300 represents a desired acceleration profile. In the "square-root" velocity profile mode of operation, feedforward signal 300 is a constant that represents the maximum command current that can be fed to plant 318. In the "time-linear arrival" velocity profile mode, on the other hand, acceleration varies linearly with respect to time. Thus, during the time-linear arrival portion of a seek operation, feedforward signal 301, which is derived from an empirically estimated acceleration, is used instead (which is itself computed from the velocity of the head as determined by estimator 308--where the acceleration is calculated from velocity as *2v/SamsToGo* and the velocity is calculated as *3x/SamsToGo*). In FIG. 3, a switch 303 represents the ability to switch from the square root velocity profile to the time-linear arrival profile. The closed-loop system of FIG. 3 uses velocity as the controlled parameter to correct feedforward signal 300 (in the square root profile) or feedforward signal 301 (in the time-linear arrival profile) in order to be used as a command signal to plant 318.

Replace paragraph [0043] with the following:

FIG. 4 is a flowchart representation of a process of controlling the arrival phase of a seek operation in a disc drive in accordance with preferred embodiments ~~a preferred embodiment~~ of the present invention. The distance to travel and time to complete the arrival phase of the seek are first calculated (block 400). The square root velocity profile is initially used in a control system as in FIG. 3 to control the deceleration of the actuator arm assembly (block 402), and the square root velocity profile continues to be used (block 404:No) until a pre-determined transition point is reached. When the transition point is reached (block 404:Yes), then the time-linear velocity profile is used instead of the square root profile (block 406) until the desired track is reached (block 408), after which time track following and track access may be enabled.

Replace paragraphs [0045-0046] with the following:

It is important to note that while the present embodiments have ~~invention has~~ been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present embodiments ~~invention~~ are capable of being distributed in the form of a computer readable medium of instructions or other functional descriptive material and in a variety of other forms and that the present embodiments are ~~invention is~~ equally applicable regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media, such as a floppy disk, a hard disk drive, a RAM, CD-ROMs, DVD-ROMs, and transmission-type media, such as digital and analog communications links, wired or wireless communications links using transmission forms,

such as, for example, radio frequency and light wave transmissions. The computer readable media may take the form of coded formats that are decoded for actual use in a particular data processing system. Functional descriptive material is information that imparts functionality to a machine. Functional descriptive material includes, but is not limited to, computer programs, instructions, rules, facts, definitions of computable functions, objects, and data structures.

The description of the present embodiments ~~invention~~ has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiments were ~~embodiment was~~ chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.